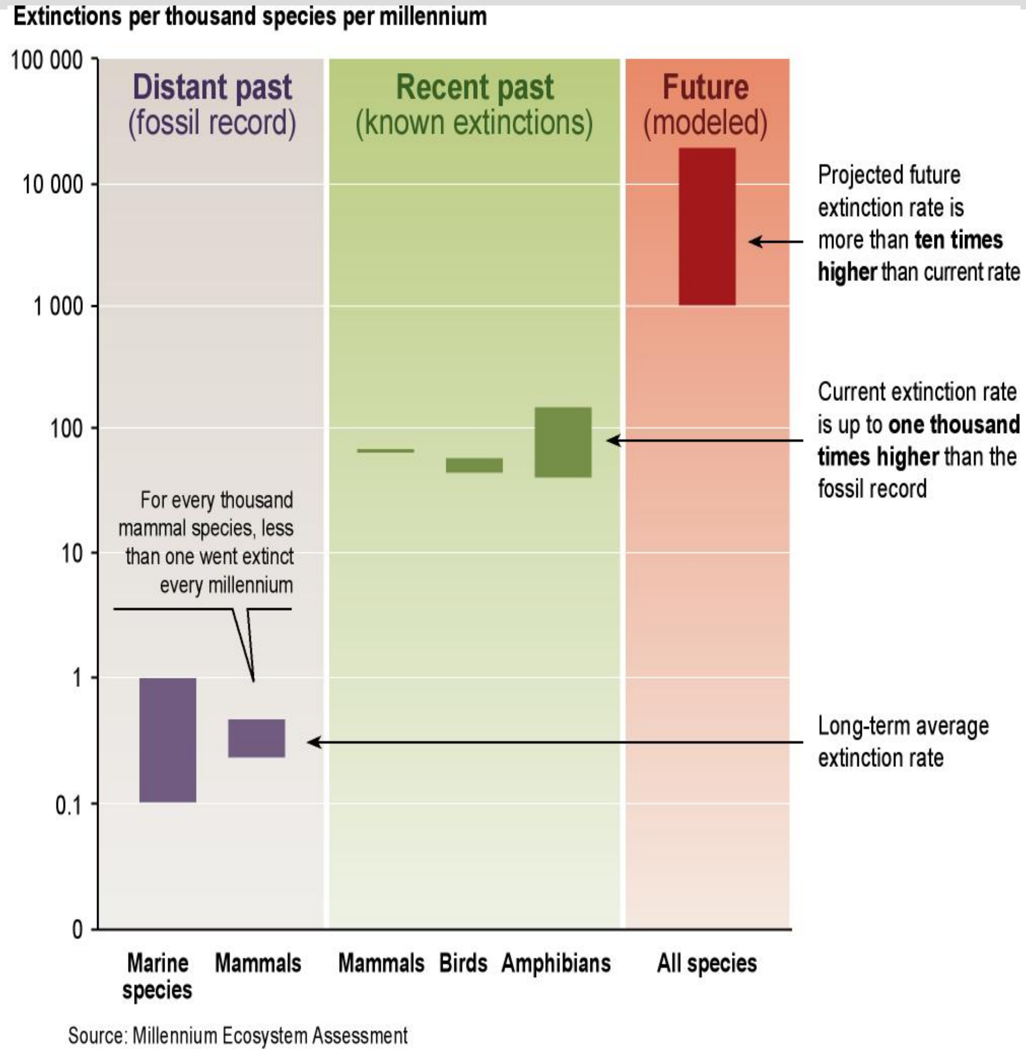
Global Observation Systems for Biodiversity

RJ (Bob) Scholes
Council for Scientific and Industrial Research
South Africa

bscholes@csir.co.za

Decline and loss of biodiversity

- The great majority of plant and vertebrate species are declining in distribution, abundance or both
- Humans have increased the species extinction rate by 50 to 1,000 times the rates typical in the fossil record
- 10–30% of mammal, bird, and amphibian species are currently threatened with extinction
- Diversity of genes and populations, and extent of near-natural ecosystems is currently declining in most places in the world

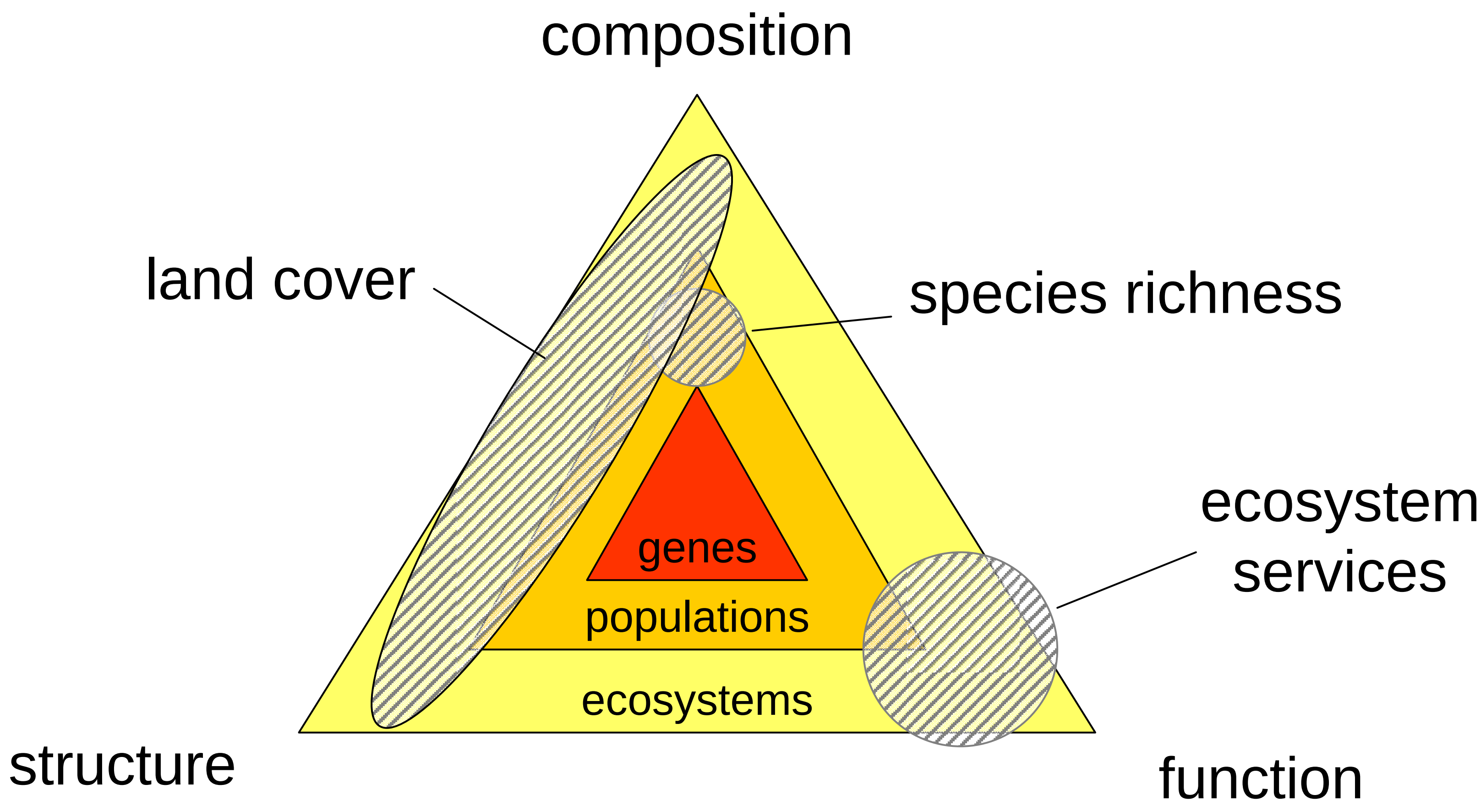


Outline

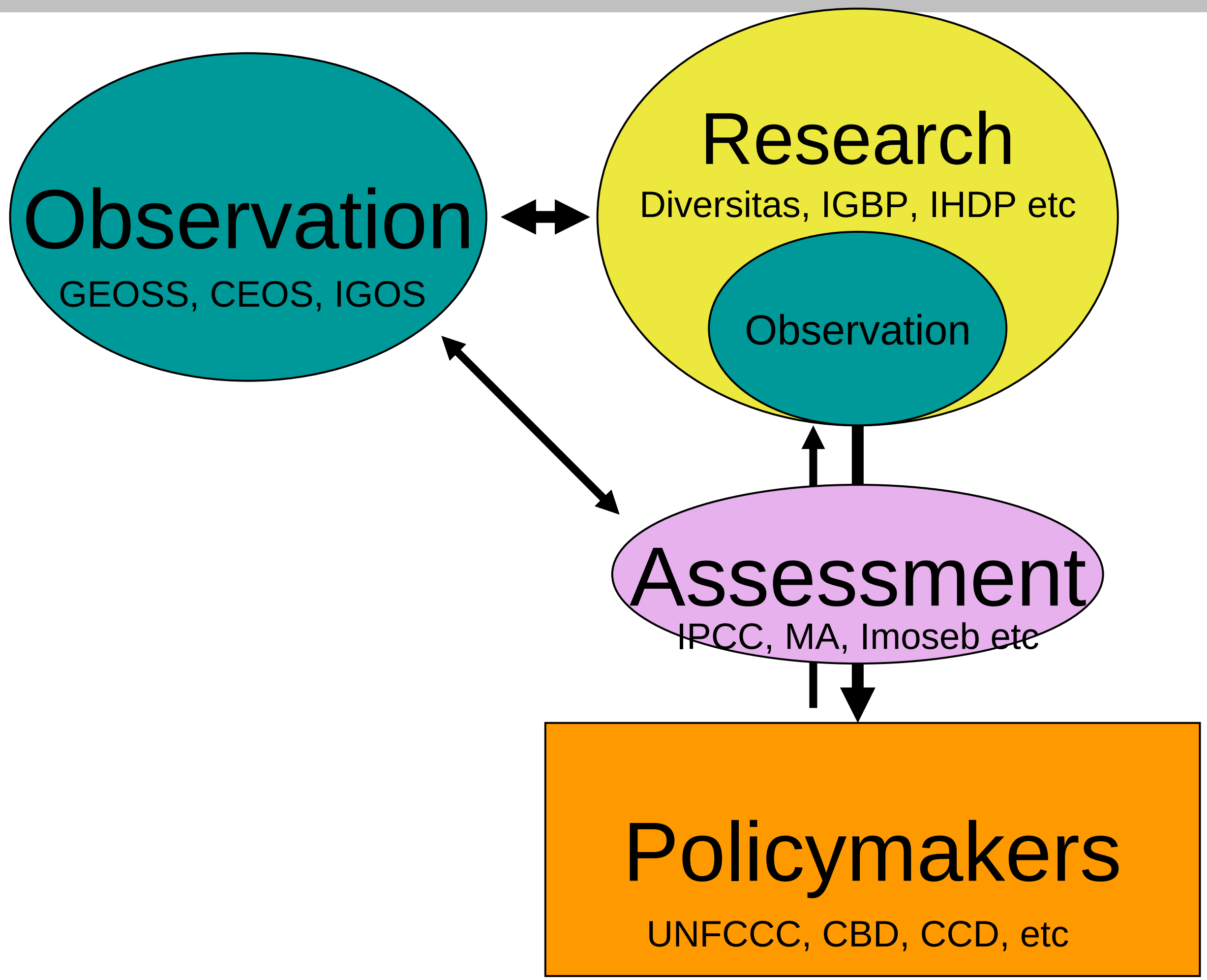
- What is biodiversity?
- What is an 'observation system'?
- Who needs it?
- How might it be organised?
- How can remote sensing help?

Biodiversity

The variety of life on earth



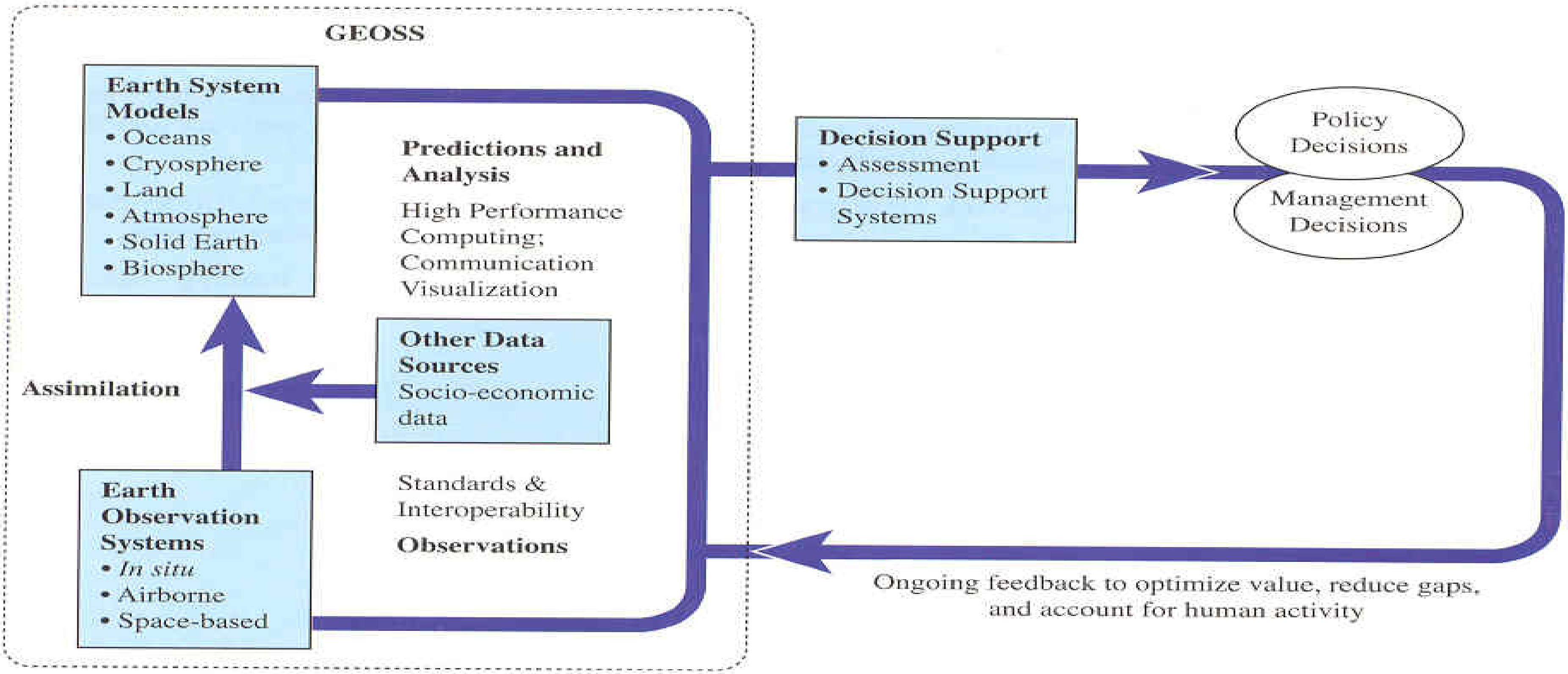
Structure of 21st century science



Observing systems

…are more than just ways of collecting data

- Complete chain from observation to use
- Seamless continuum from observations to products

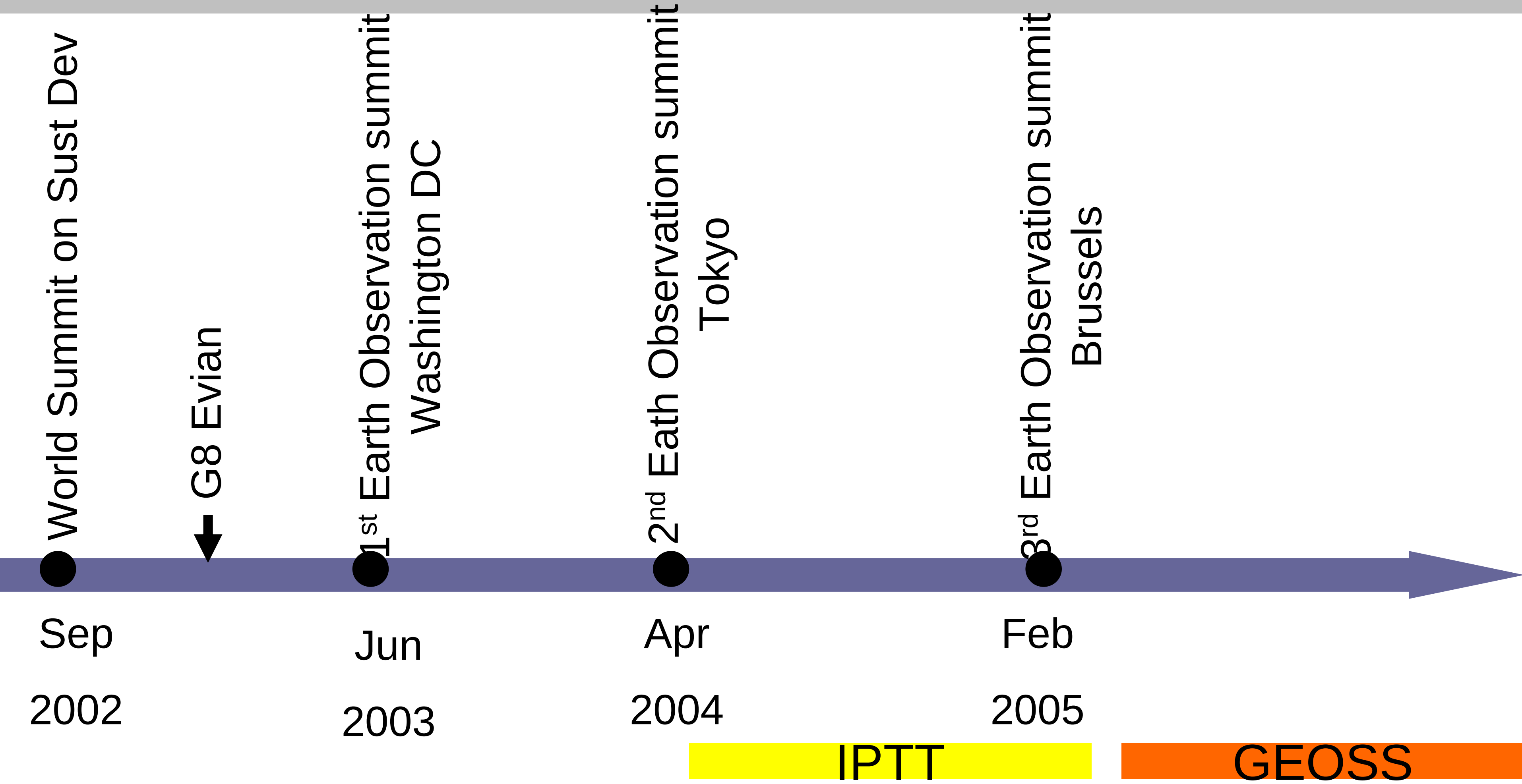


So what is the problem?

- The picture with respect to biodiversity is patchy
  - Geographical gaps (tropics, southern hemisphere)
  - Topical gaps (invertebrates, marine organisms)
  - Inconsistency in space and time
- The delivery pipeline is blocked
  - *Many* more data are collected than are used
  - Key constraint is ‘interoperability’
  - Requires
    - Data sharing policies and protocols
    - Harmonisation of methods

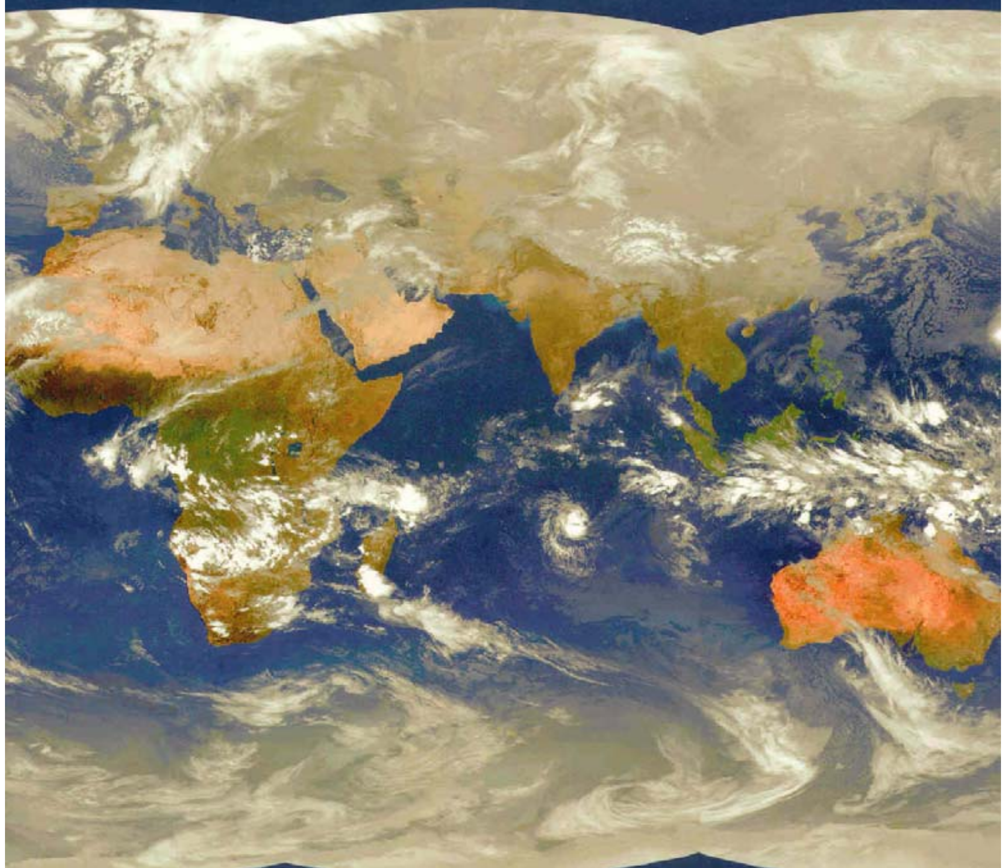
A political process to help fix the problem

Global Earth Observing System of Systems



GEO 1000R
February 2005

Global Earth Observation System of Systems GEOSS



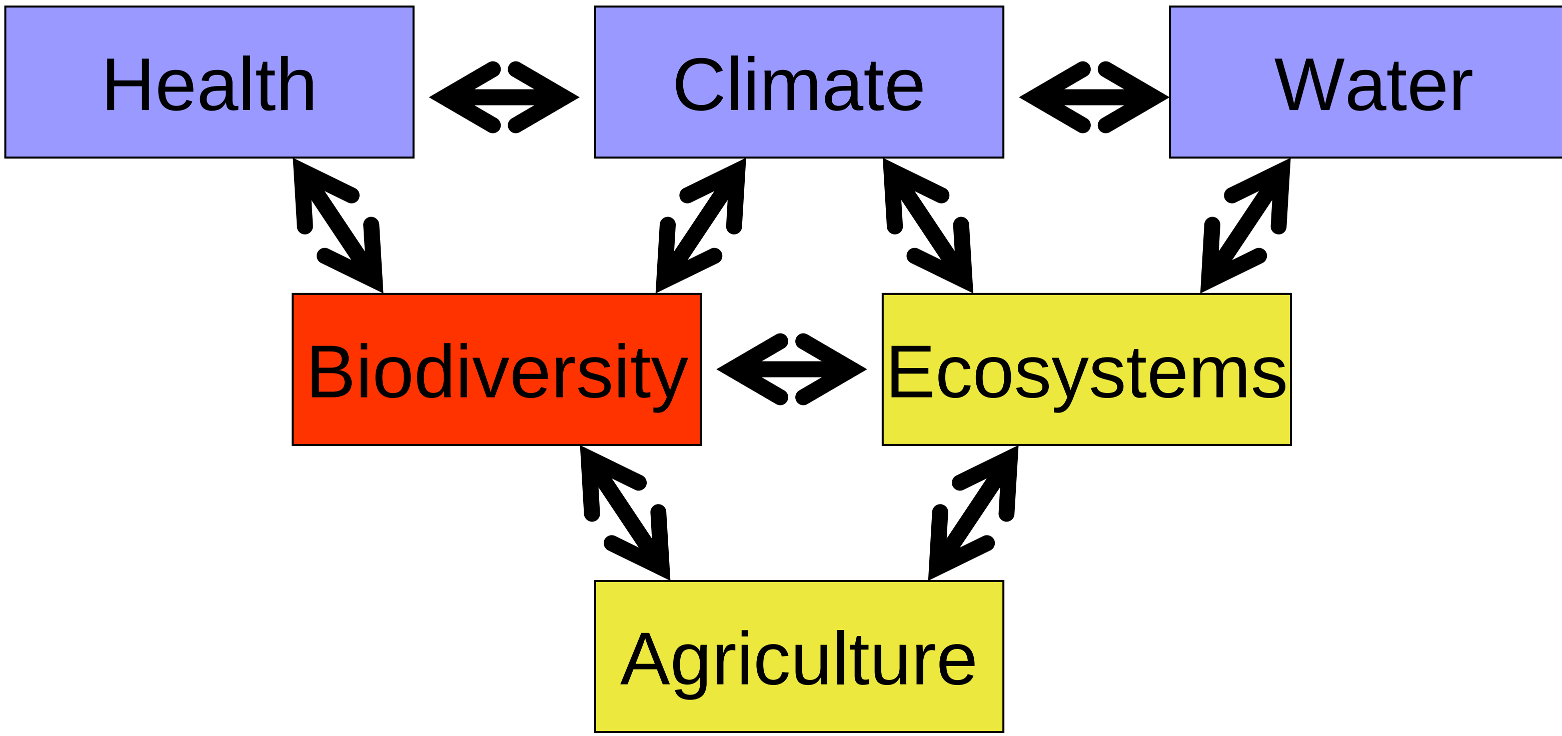
10-Year Implementation Plan Reference Document

Group on Earth Observations

GEOSS’ 9 Societal Benefit Areas

- Natural Hazards and Disasters
- Human Health
- Energy Resource Management
- Weather
- Water
- Climate
- Ecosystems
- Agriculture
- Biodiversity

Benefits of integration



Users of a biodiversity observation system

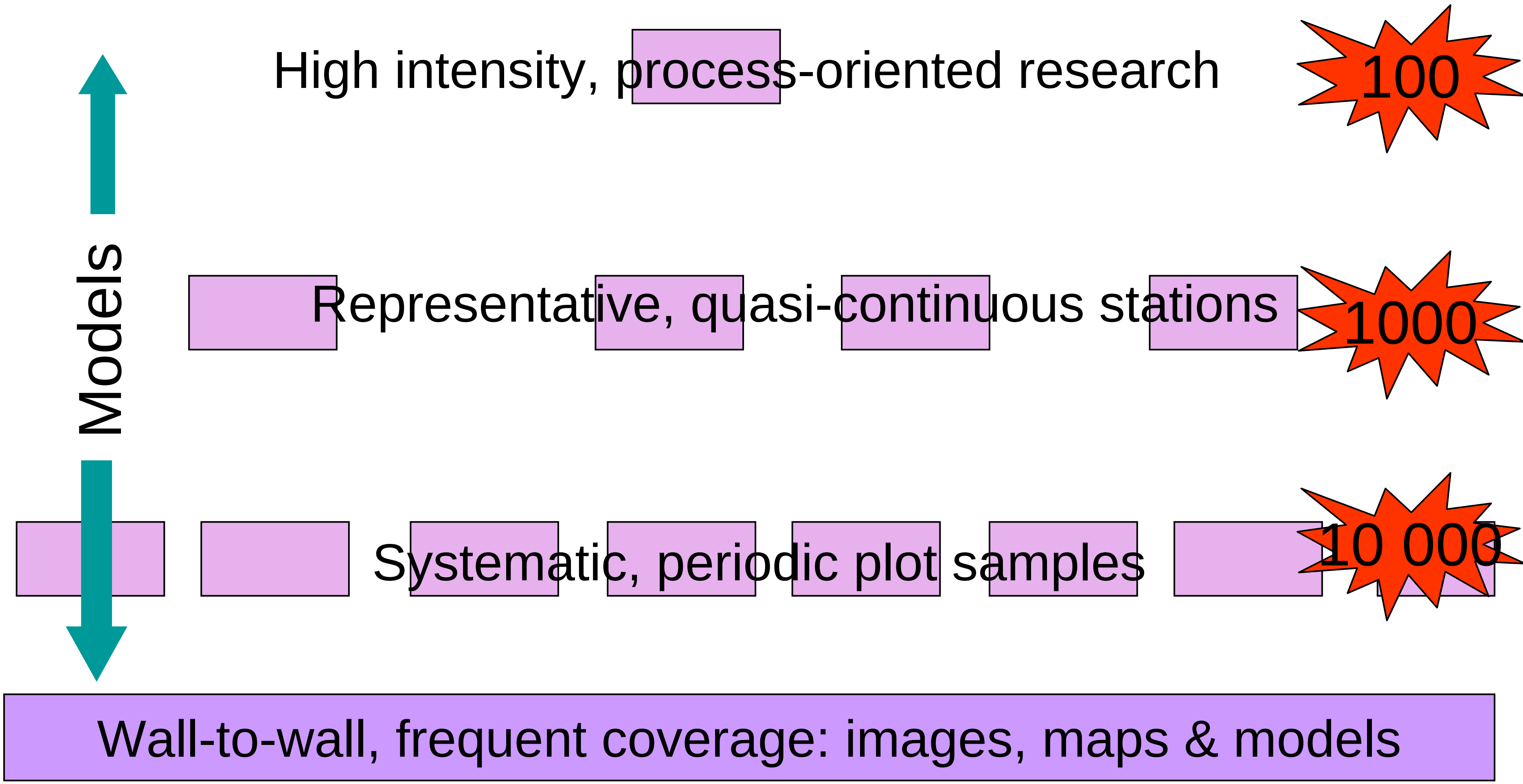
- International treaty processes
  - CBD, CCD, CITES, Ramsar, CMS
- Biodiversity and conservation NGOs
  - IUCN, WWF, CI, WCS, TNC etc
- National and local conservation agencies and biodiversity custodians
- Researchers

Information needs revealed by MA

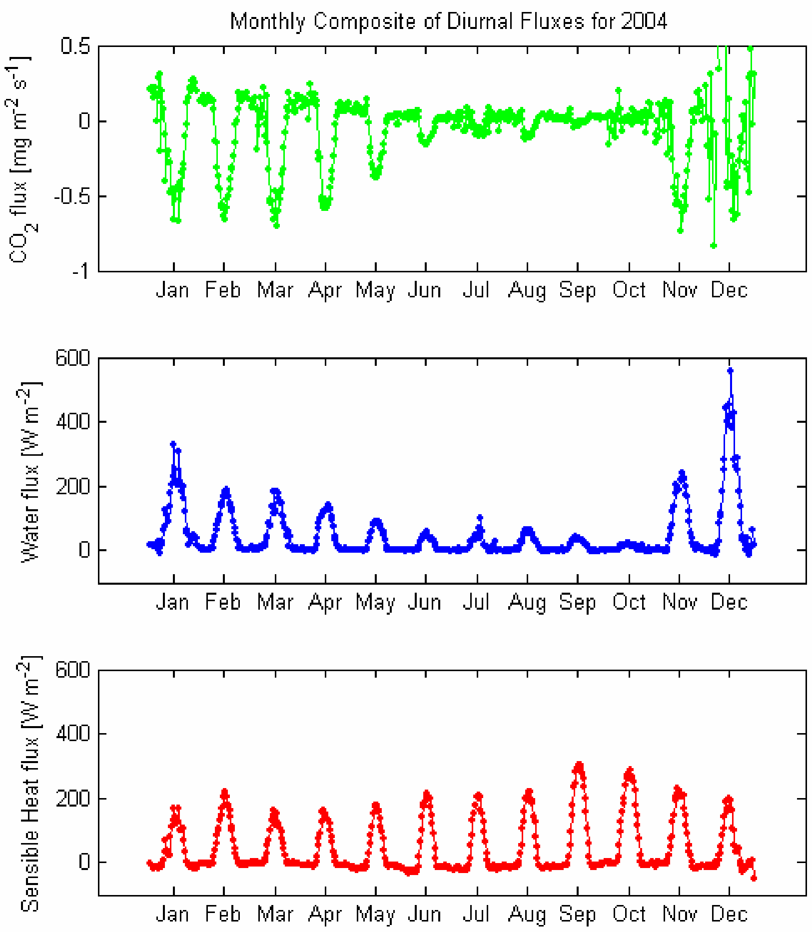
- Genuinely global databases
  – Consistent, reliable, all ecosystems
- Time series of change
- Information beyond species richness
  – Presence/absence is an insensitive indicator
- *Functional* biodiversity
  – Ecosystem services: particularly support, regulation and spiritual/recreational services
- Linked, georeferenced socio-economic data

The concept of sample hierarchies

GTOS Global Hierachical Observation SysTem



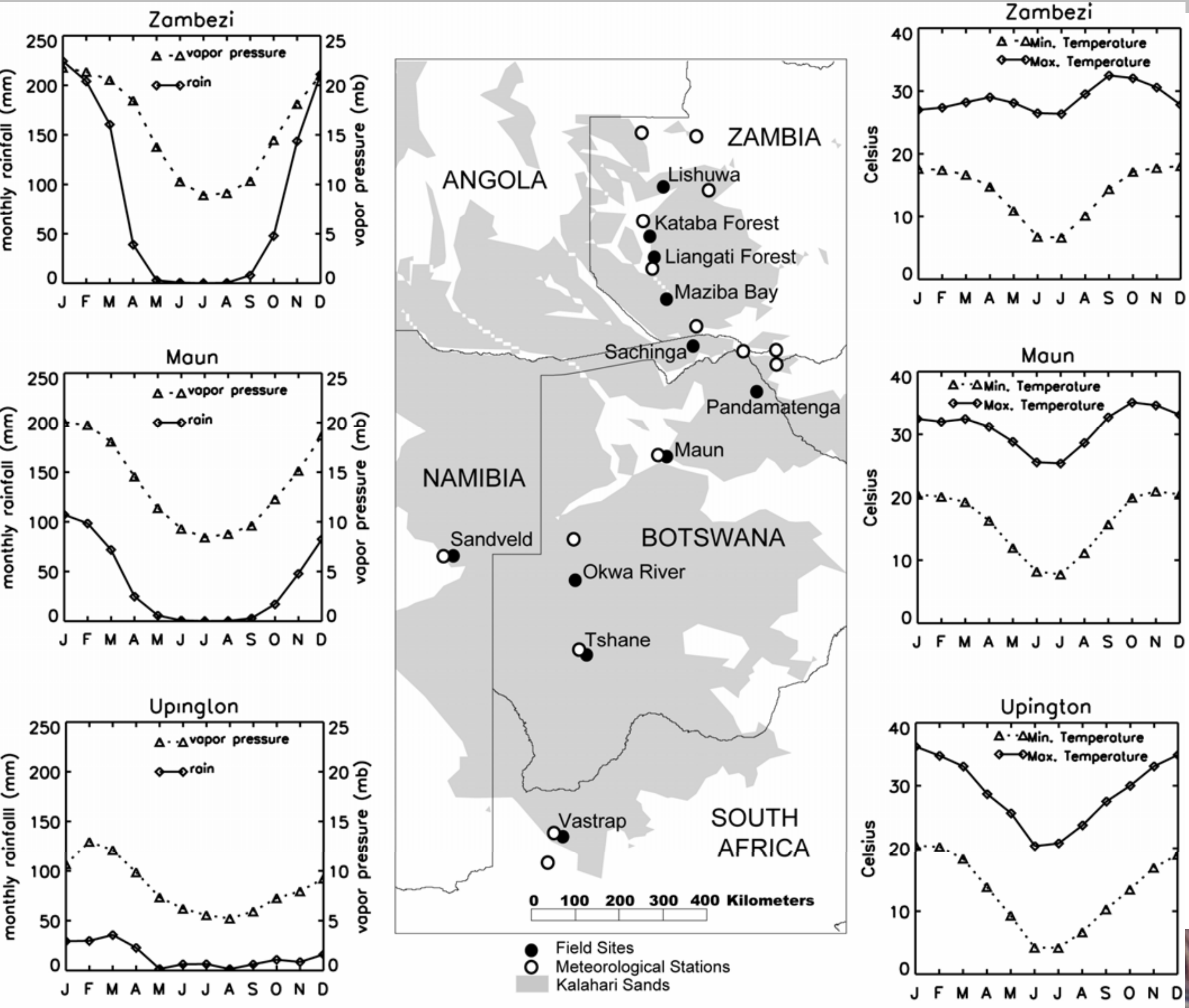
Tier 1: Intensive research sites



Skukuza, Kruger Park, South Africa

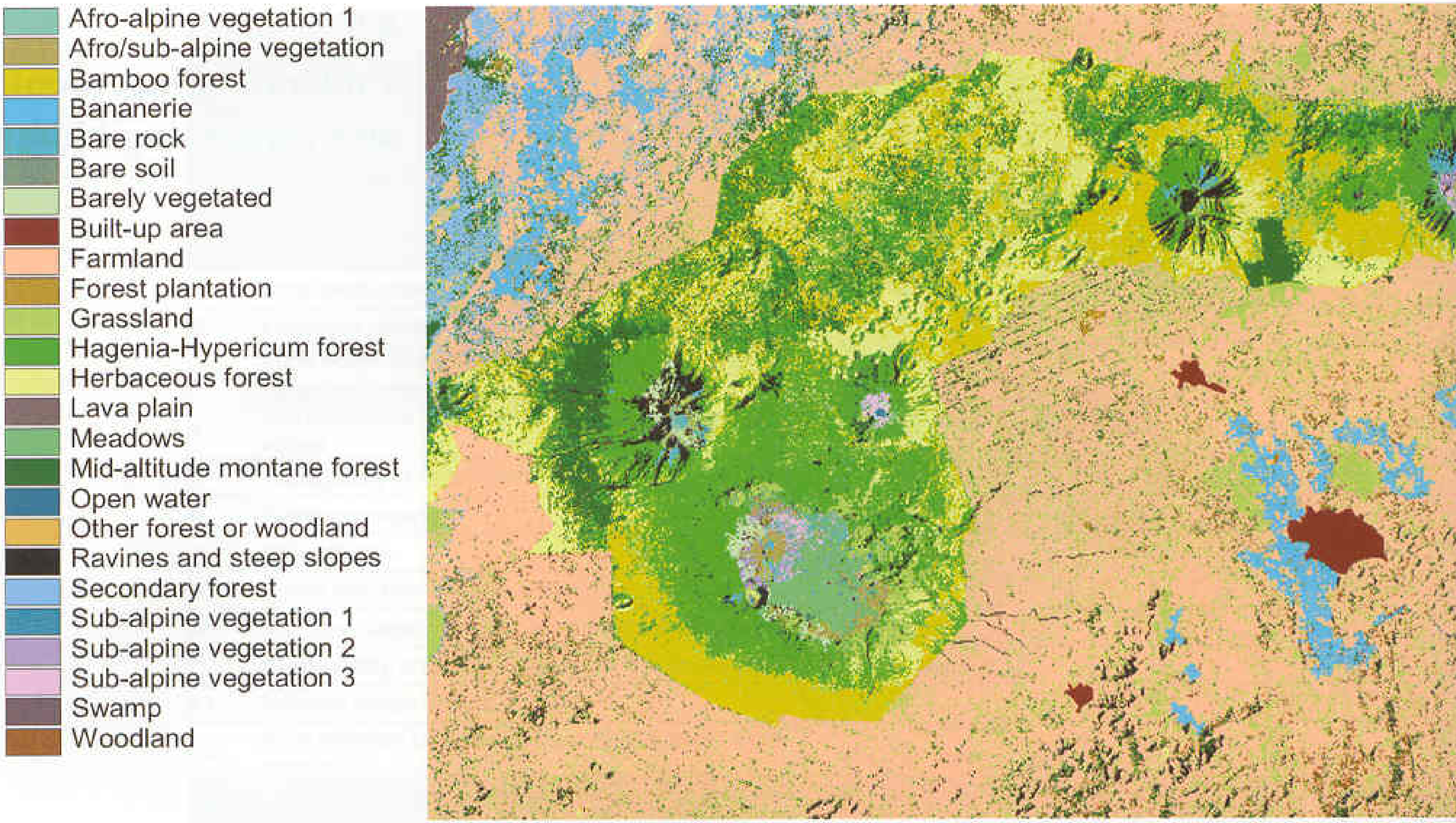
Tier 2: Stations

Tier 3: plots



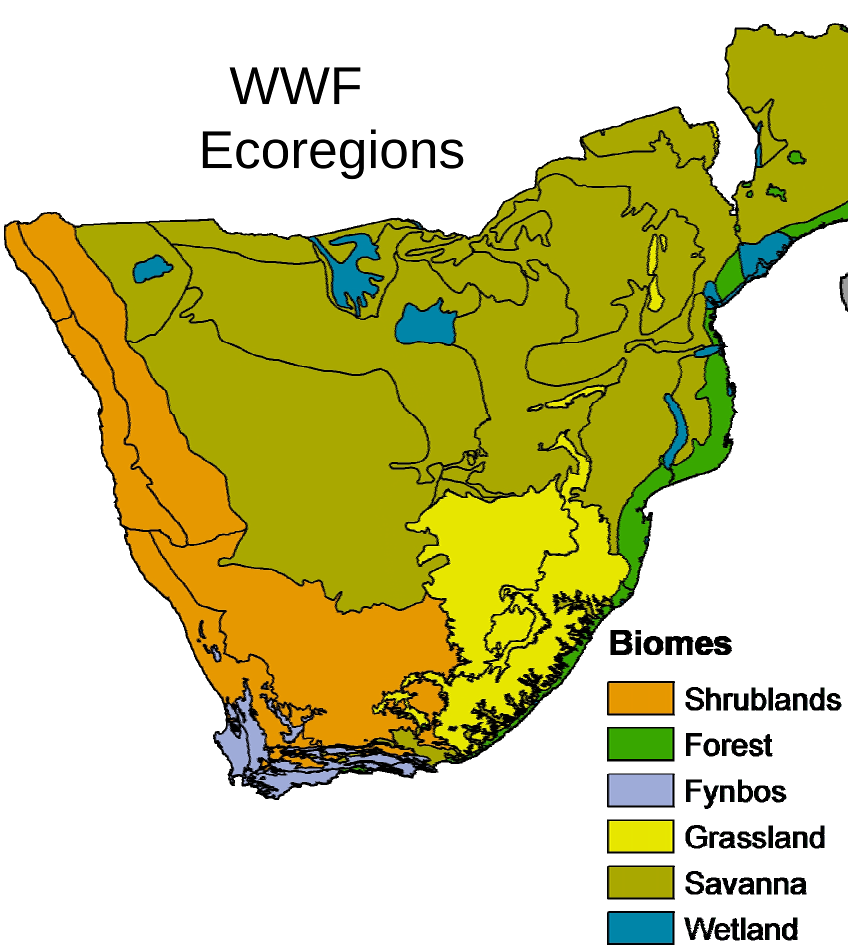
Kalahari transect

Tier 4: Wall-to-wall observational products

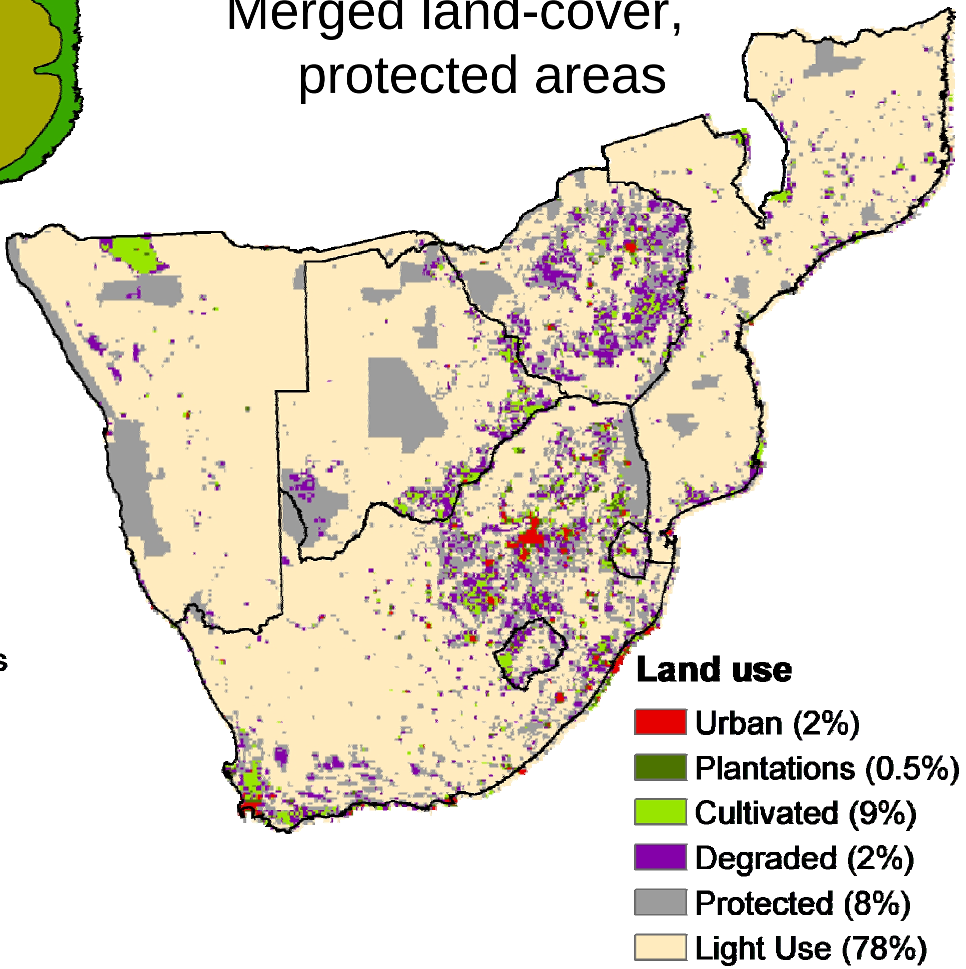


Land cover and use are central

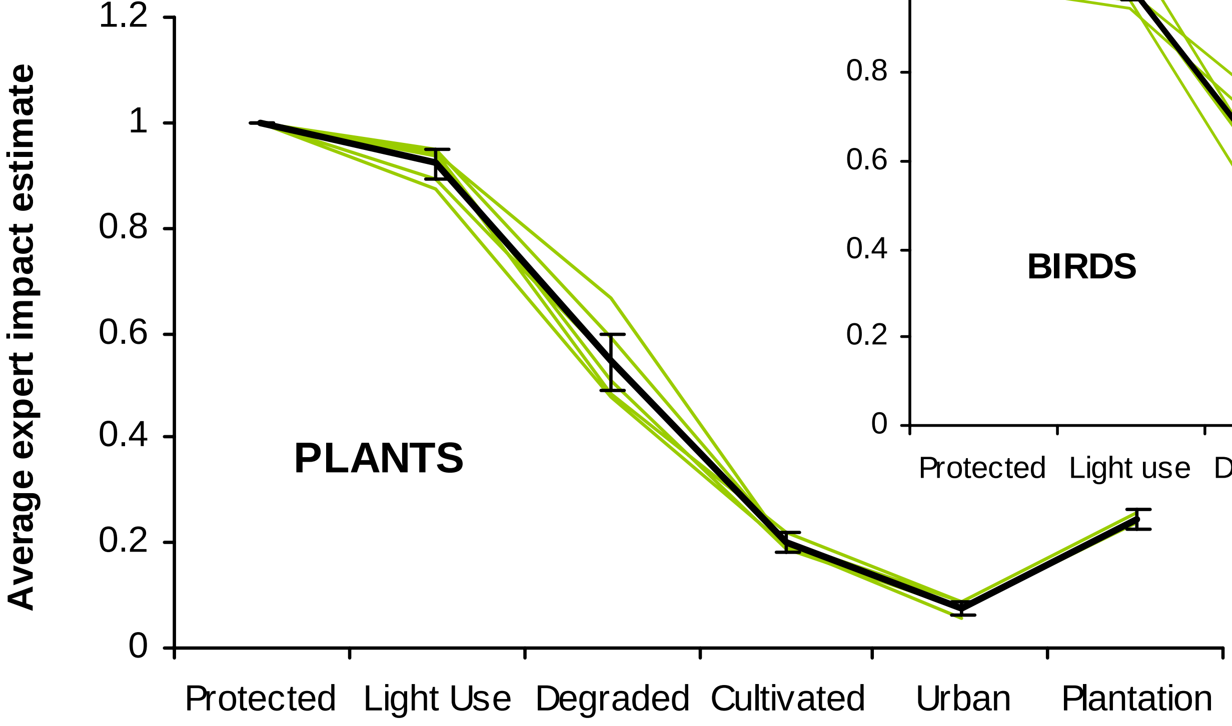
WWF Ecoregions

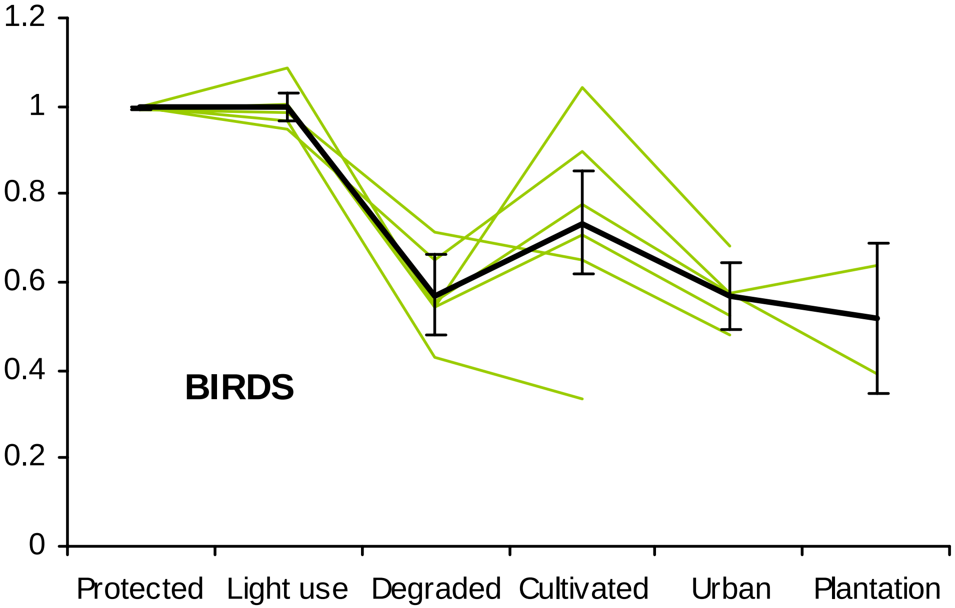


Merged land-cover, protected areas



Effect of ecosystem use on population abundance





Scholes & Biggs (2005) Nature 434:45-48

Interoperability

Biodiversity shows the way

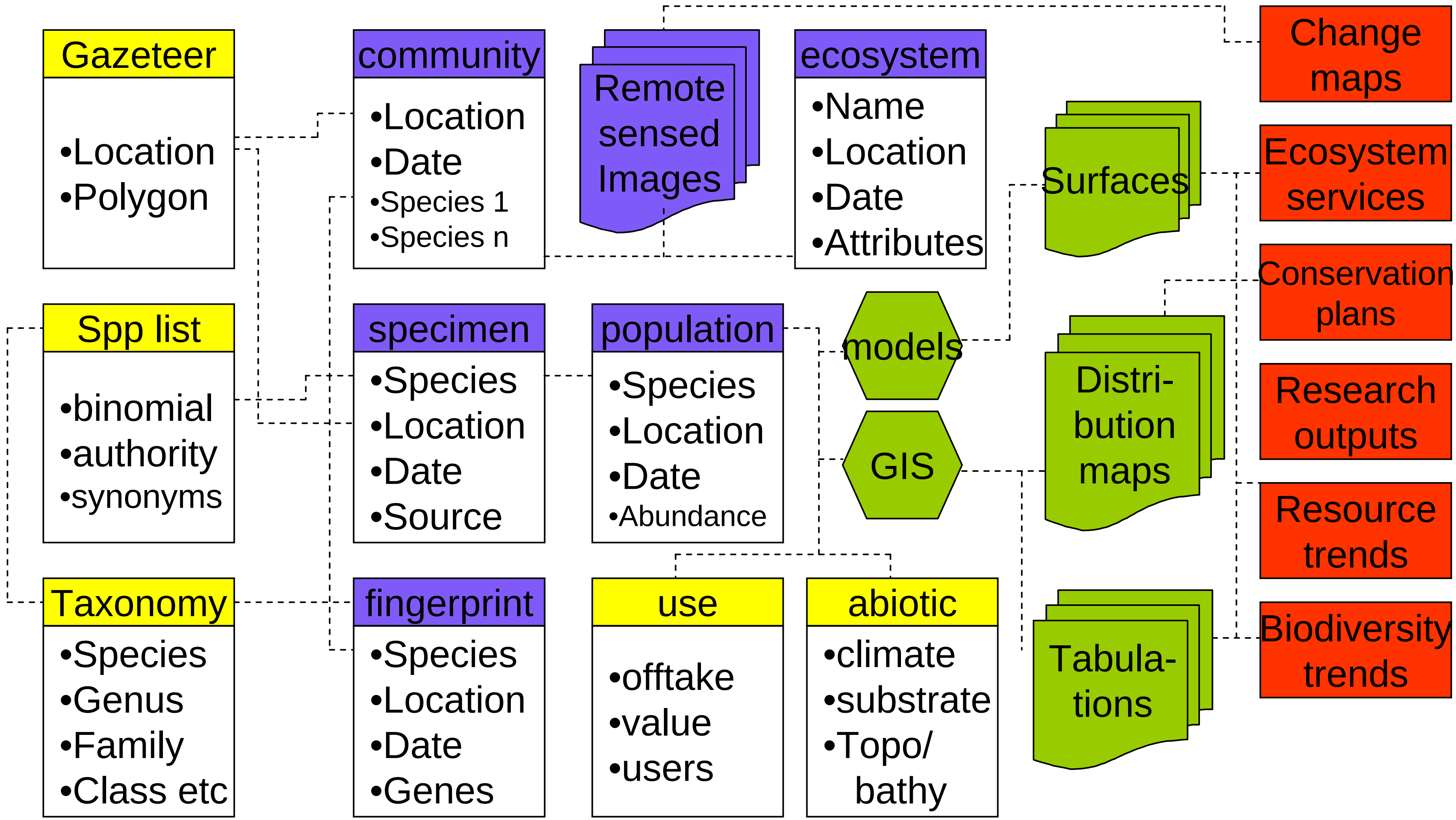
***Broadly*: making information in one system available to other systems**

- Sharing agreements, transparency, standards

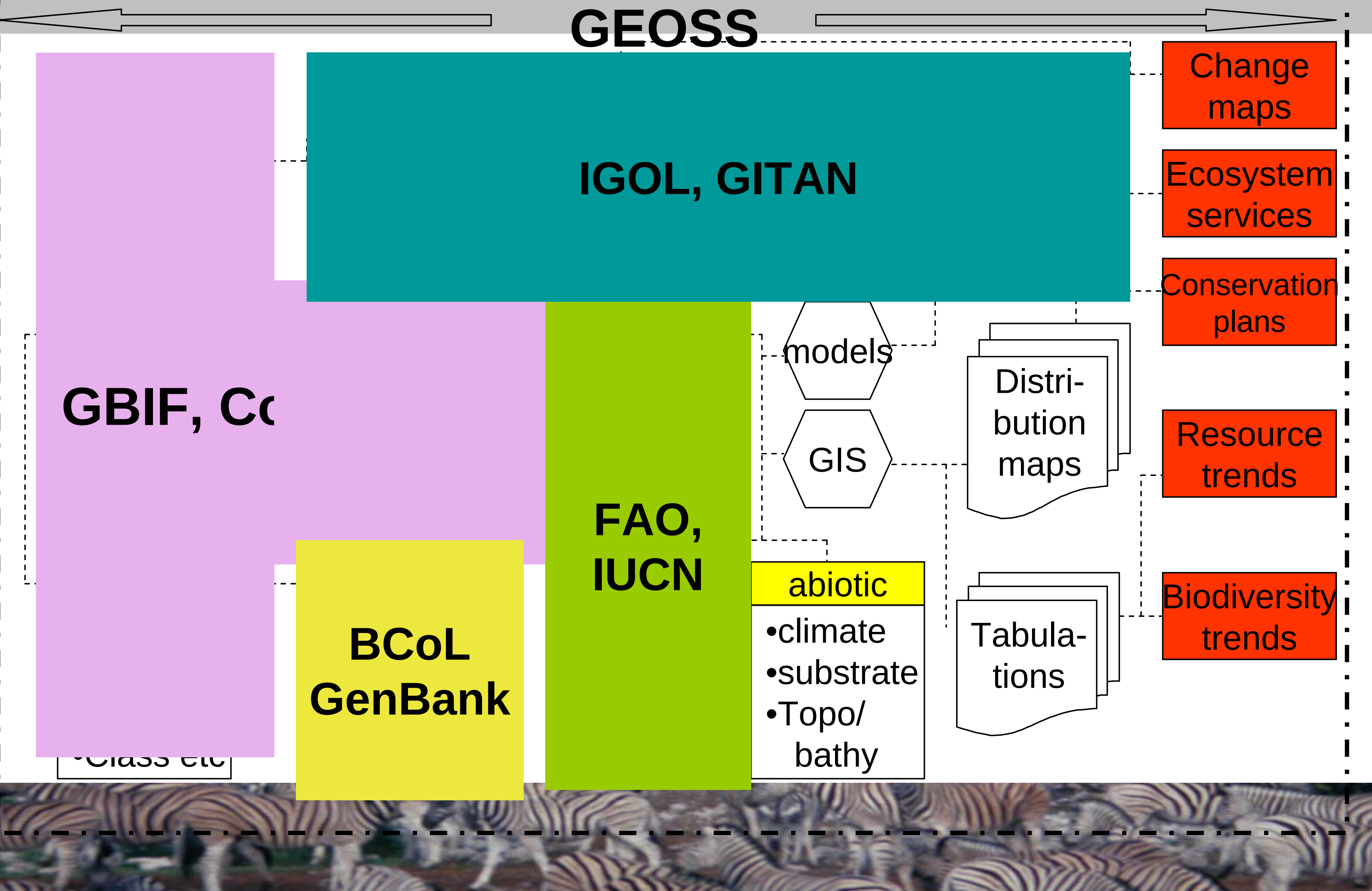
***Narrowly*: Ways of coding information so that it can be queried and interpreted by other systems**

- ABCD: Access to Biodiversity Collection Data
- Darwin Core
- EML: Ecological Metadata Language

An architectural sketch



Responsibilities



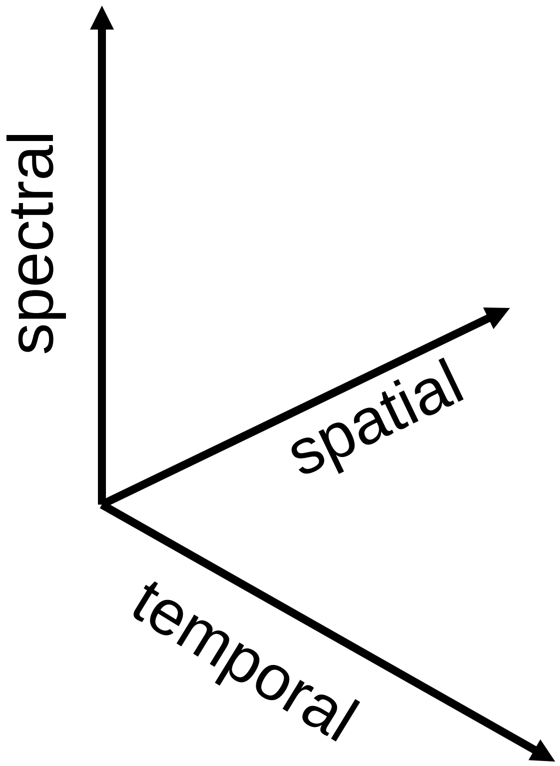
Ongoing and near future activities

- GEOSS Work Package 60
  - Ecosystem classification
  - Site networks
- Mid-decade land cover (for 2010 target)
- Linking of digital collection records (GBIF)
- Interpolation of species distributions

Not so impossible dreams…

- Remote sensing of biological communities and individual organisms
  - Hyperspectral (100's of narrow bands)
  - Hypertemporal (daily to weekly observations)
  - Hyperspatial (~ 1 m resolution)
- Population dynamics of many species, under a range of pressures
- Extensive genetic information for important functional groups
- Fully integrated volunteer networks

Remote sensing as a cube…

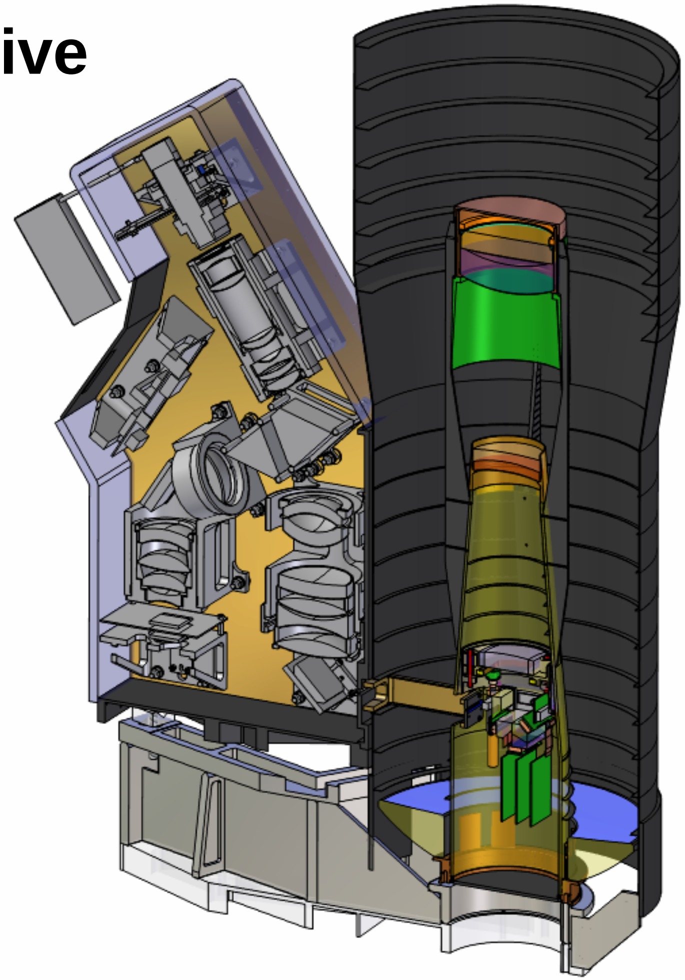


Hyperspectral imagery

may be able to distinguish individual dominant species

Multi-Sensor Microsatellite Initiative

To fly on ZASat ~ Dec 07
Hyperspectral instrument by Belgium
200 bands, 10 nm wide, 400-2400 nm
15 m GSD
15 km swath
~ 4 revisits/year



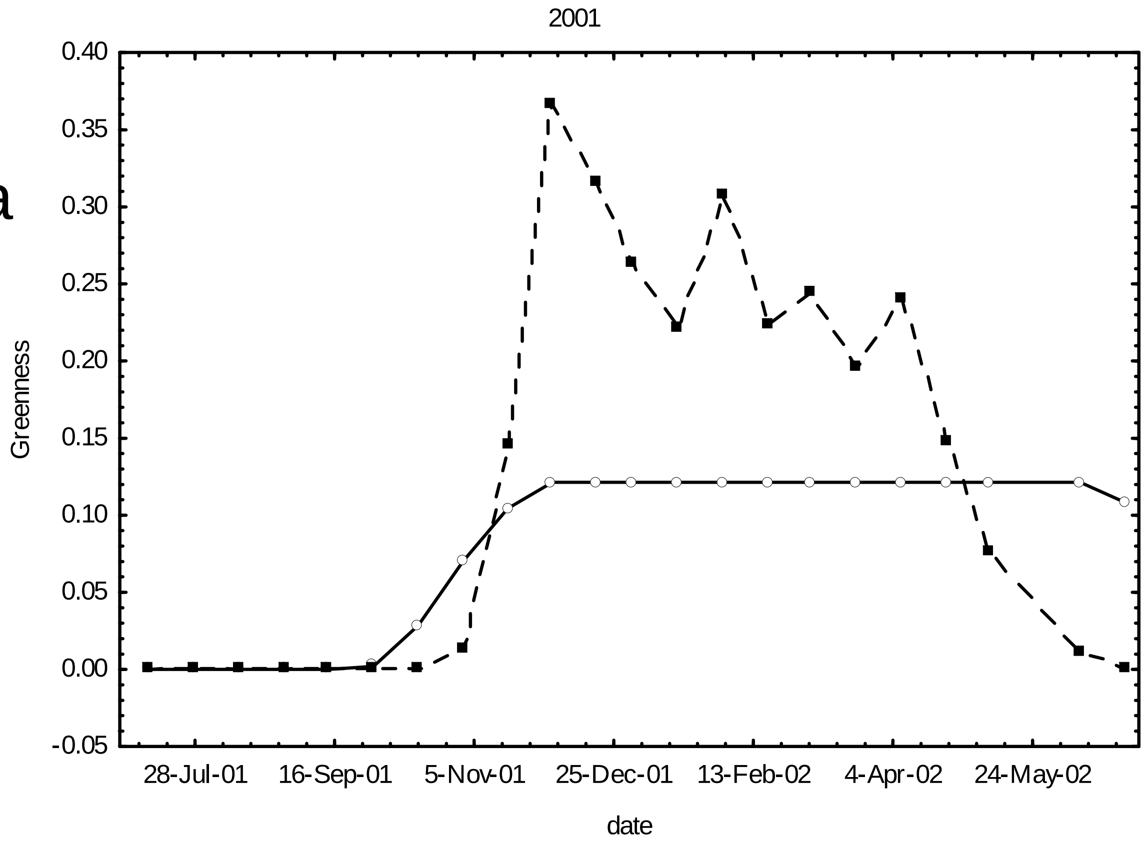
‘Hypertemporal’ imagery

is our best chance to obtain ecosystem function information

GPP = ♏Σ(FPAR*PAR)

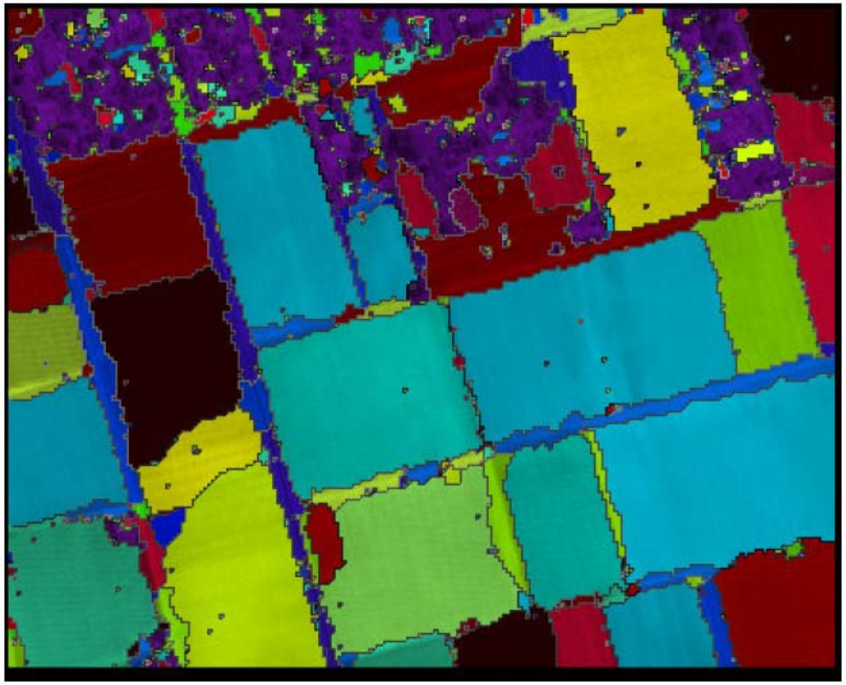
Modis data

also AVHRR, Envisat etc



‘Hyperspatial’ imagery
tells us about fine structure

PAN image
(QuickBird 1 m GSD)



Segmented image, colourised to show structurally different covers

Other remote sensing of structure…

- SAR
  - Sees through clouds (very important in the tropics)
  - 20-30 m resolution
  - Demonstrated ability to map biomass 10-50 Mg/ha
  - Potential for mapping wetlands
- Lidar
  - Vertical and horizontal profiling of vegetation
  - Intuitive ecological interpretation
  - No space-based instruments yet
- BDRF

Summary

- Biodiversity observations are abundant for *species* at *point locations,* but poorly accessible
- Ecosystem-scale time-series products are essential, but rare
- Remote sensing has much to offer in *contributing* to an integrated biodiversity observation system, especially
  - Land and sea ecosystem type, extent and fragmentation
  - Ecosystem function indicators